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(54) **SELF ALIGNING AND SELF LATCHING MECHANICAL SHAFT CONNECTOR**

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See application file for complete search history.

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- F16K 27/08** (2006.01)
- F16D 1/10** (2006.01)
- F16K 31/00** (2006.01)

(57) **ABSTRACT**

According to one aspect, embodiments of the invention provide a self-aligning connector system for connecting an actuator to a valve body of a valve, comprising an actuator adapter plug having a conical protrusion and a peripheral groove formed in an outer surface of the actuator adapter plug, and a valve adapter sub-assembly comprising an outer housing having a bore configured to receive the actuator adapter plug, and an expansion spring coupled to the outer housing and configured to provide radial pressure on the outer housing to receive the conical protrusion of the actuator adapter plug and latch onto the peripheral groove.

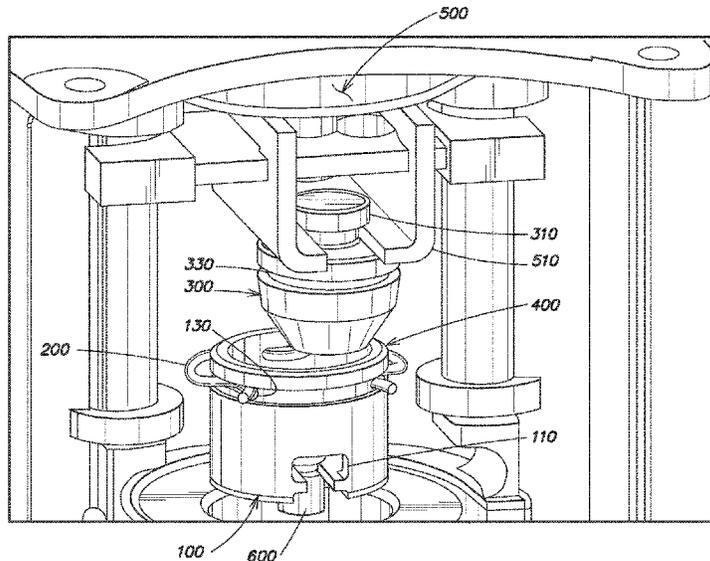
(52) **U.S. Cl.**

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19 Claims, 4 Drawing Sheets



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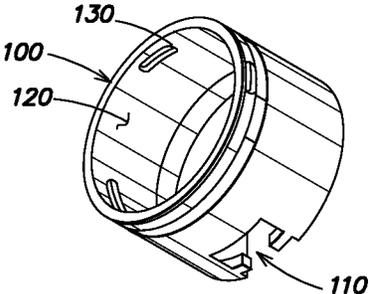


FIG. 1A

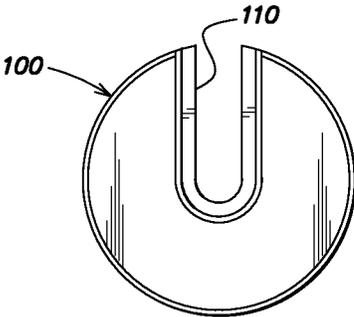


FIG. 1B

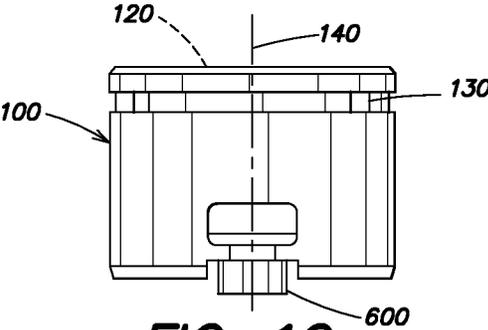


FIG. 1C

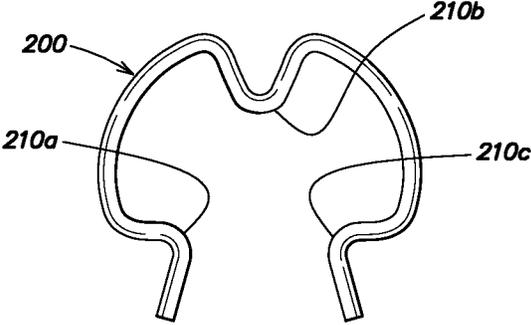


FIG. 2

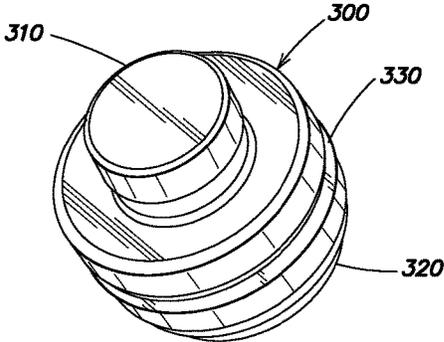


FIG. 3A

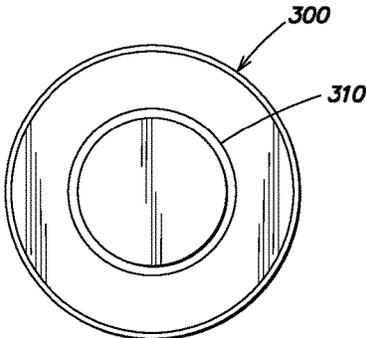


FIG. 3B

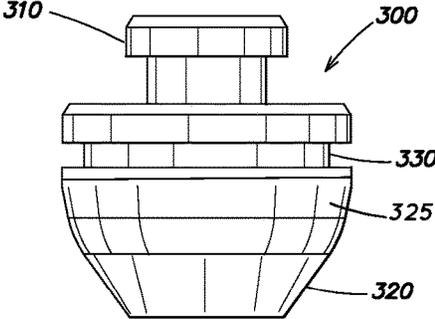


FIG. 3C

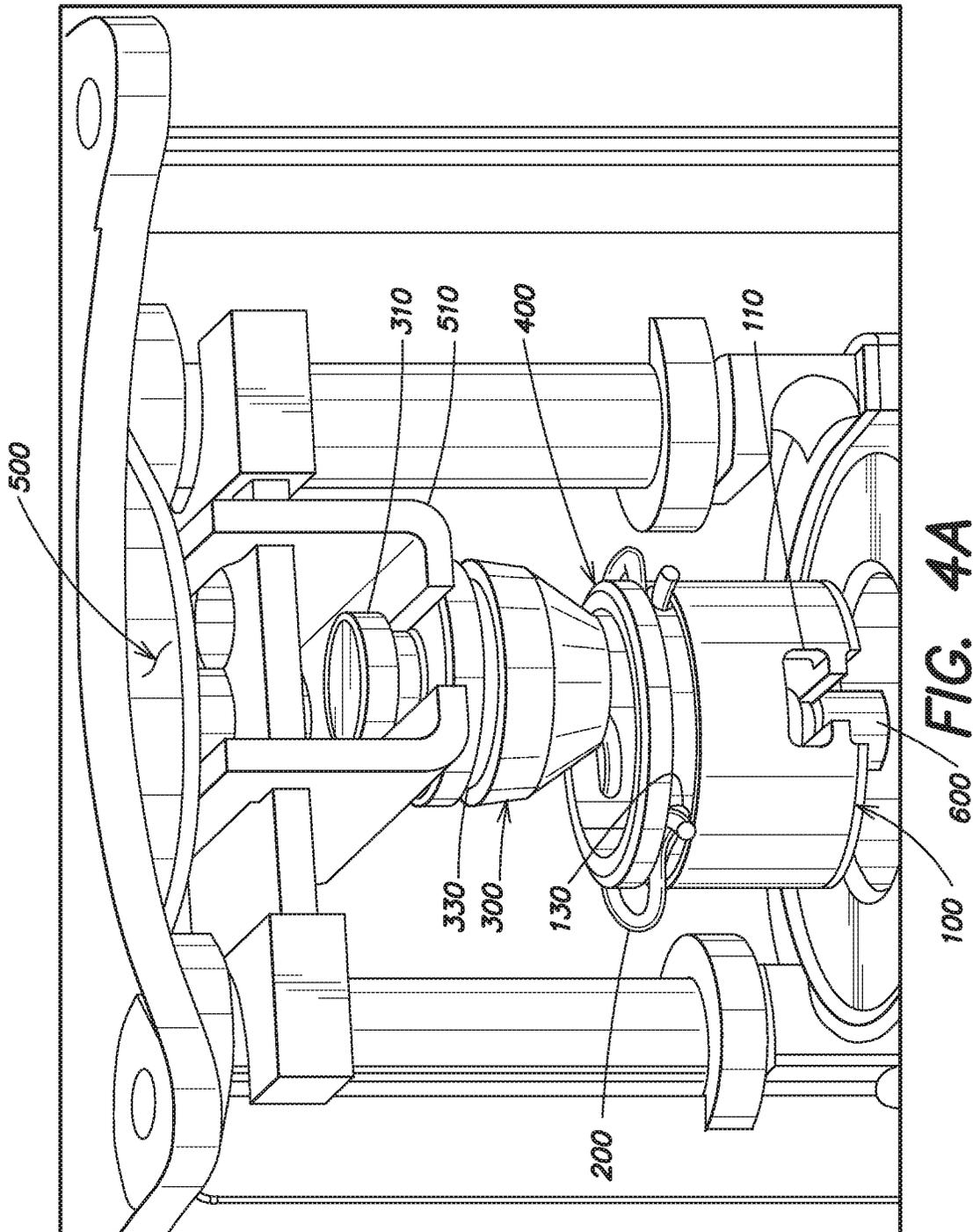


FIG. 4A

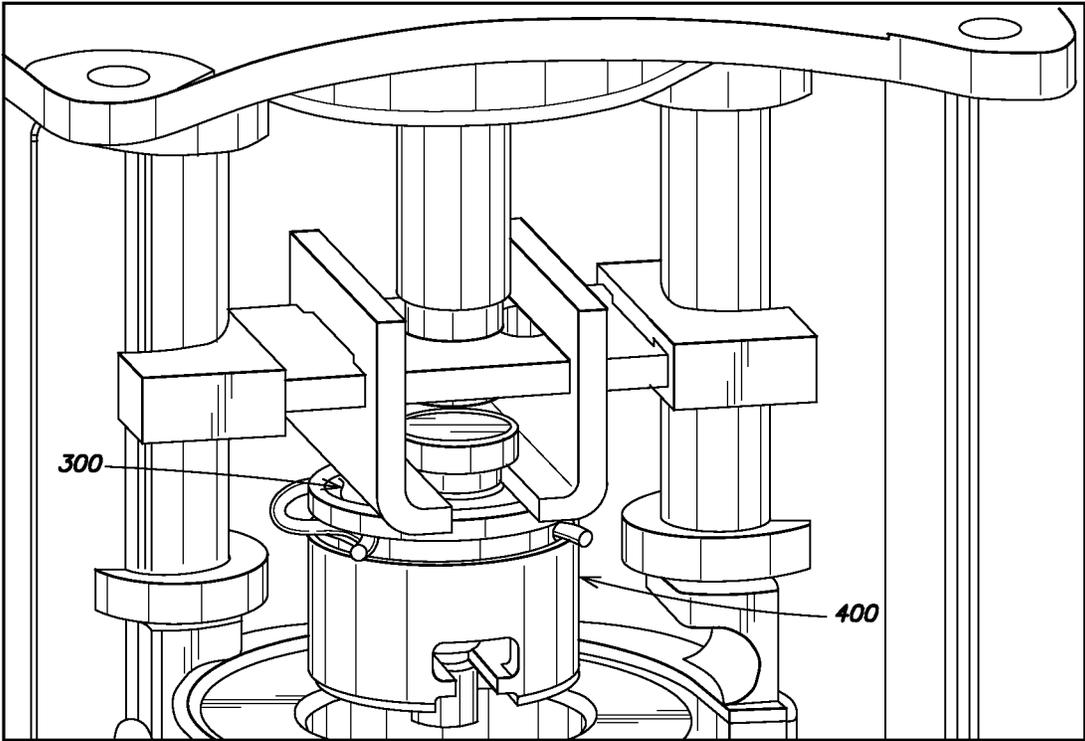


FIG. 4B

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**SELF ALIGNING AND SELF LATCHING
MECHANICAL SHAFT CONNECTOR****CROSS-REFERENCE TO RELATED
APPLICATIONS**

This application claims priority to U.S. Provisional Patent Application No. 62/408,483 filed Oct. 14, 2016, entitled SELF ALIGNING AND SELF LATCHING MECHANICAL SHAFT CONNECTOR, which is incorporated by reference herein in its entirety.

BACKGROUND**Field of Invention**

Embodiments of the present invention relate generally to actuator driven valves, and more particularly to a releasable connection of an actuator to a valve body in a valve apparatus.

Discussion of Related Art

In valve apparatuses having an actuator, it is sometimes desirable to have the actuator be connected to and/or removed from a valve stem of another operating member of a valve.

SUMMARY

According to principles of the present invention, a self-aligning and self-latching mechanical shaft connector may be used to connect an actuator to a valve body of a valve. In at least one embodiment, the shaft connector has an actuator adapter plug and a valve adapter sub-assembly. The actuator adapter can have a connector mechanism for engaging with an actuator and can have a conical protrusion opposite the connector mechanism and a peripheral groove along the actuator adapter plug body. The valve adapter sub-assembly can include an outer housing having a recessed receptacle for receiving a protrusion from a valve body and a bore for receiving the actuator adapter plug, and an expansion spring placed within the outer housing. The expansion spring can provide radial pressure toward the axis of the outer housing to receive the conical protrusion and latch onto the peripheral groove of the actuator adapter plug.

Aspects in accord with the present invention are directed to a self-aligning connector system for connecting an actuator to a valve body of a valve, comprising an actuator adapter plug having a conical protrusion and a peripheral groove formed in an outer surface 325 of the actuator adapter plug, and a valve adapter sub-assembly comprising an outer housing having a bore configured to receive the actuator adapter plug, and an expansion spring coupled to the outer housing and configured to provide radial pressure on the outer housing to receive the conical protrusion of the actuator adapter plug and latch onto the peripheral groove.

According to one embodiment, the conical protrusion is configured to interface with the outer housing to self-align the actuator adapter plug and compensate for axis offset errors when the actuator adapter plug is inserted into the bore. In another embodiment, the conical protrusion is configured to expand the expansion spring as the actuator plug is inserted into the bore. In one embodiment, the expansion spring comprises at least one protrusion configured to engage with the peripheral groove.

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According to another embodiment, the actuator adapter plug further comprises a connector mechanism configured to engage with the actuator. In one embodiment, the connector mechanism is further configured to engage with at least one bracket of the actuator. In another embodiment, the connector mechanism is further configured to engage with at least one of an anti-rotation bracket and a u-bracket of the actuator.

According to one embodiment, the outer housing comprises at least one opening configured to allow the at least one protrusion of the expansion spring to protrude into the bore. In another embodiment, the at least one protrusion of the expansion spring includes a plurality of protrusions and the at least one opening of the outer housing includes a plurality of openings. In one embodiment, the plurality of protrusions includes three protrusions.

Another aspect in accord with the present invention is directed to a method for coupling an actuator with a valve body of a valve, the method comprising engaging a connector mechanism of an actuator adapter plug with the actuator, inserting a conical protrusion of the actuator adapter plug into a bore of a valve adapter sub-assembly coupled to the valve body, providing radial pressure toward an axis of the valve adapter sub-assembly as the conical protrusion is inserted into the bore, and latching the actuator adapter plug to the valve adapter sub-assembly using an expansion spring of the valve adapter sub-assembly that fits into a peripheral groove of the actuator adapter plug.

According to another embodiment, the method further comprises receiving, with a recessed receptacle of the valve adapter sub-assembly, a protrusion from the valve body. In one embodiment, receiving the protrusion from the valve body includes sliding the protrusion from the valve body into the recessed receptacle.

According to one embodiment, engaging the connector mechanism with the actuator comprises sliding the connector mechanism into at least one bracket of the actuator. In another embodiment, inserting the conical protrusion into the bore of the valve adapter sub-assembly comprises self-aligning the actuator adapter plug to compensate for axis offset errors as the conical protrusion is inserted into the bore. In one embodiment, inserting the conical protrusion into the bore of the valve adapter sub-assembly comprises expanding the expansion spring as the conical protrusion is inserted into the bore.

At least one aspect in accord with the present invention is directed to a valve assembly comprising an actuator, a valve body, an actuator adapter plug configured to be coupled to the actuator, a valve adapter sub-assembly configured to be coupled to the valve body and comprising an outer housing having a bore configured to receive the actuator adapter plug, and means for self-aligning the actuator adapter plug to compensate for axis offset errors when the actuator plug is inserted into the bore and for coupling the valve adapter sub-assembly to the actuator adapter plug.

According to one embodiment, the actuator adapter plug further comprises means for engaging with the actuator. In another embodiment, the valve adapter sub-assembly further comprises means for receiving a protrusion from the valve body.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings are not intended to be drawn to scale. In the drawings, each identical or nearly identical component that is illustrated in various figures is represented

by a like numeral. For purposes of clarity, not every component may be labeled in every drawing. In the drawings:

FIG. 1A is an isometric view of an outer housing of a valve adapter sub-assembly in accordance with principles of the invention;

FIG. 1B is a bottom view of the outer housing of FIG. 1A in accordance with principles of the invention;

FIG. 1C is a cross sectional side view of the outer housing of FIG. 1A engaged with a valve in accordance with principles of the invention.

FIG. 2 is a top view of an expansion spring that may be used in connection with the outer housing of FIG. 1A;

FIG. 3A is an isometric view of an actuator adapter plug of an actuator in accordance with principles of the invention;

FIG. 3B is a top view of the plug of FIG. 3A;

FIG. 3C is a side view of the plug of FIG. 3A;

FIG. 4A is an isometric view of the valve adapter sub-assembly mounted on a valve and actuator adapter plug mounted on an actuator in accordance with principles of the invention; and

FIG. 4B is an isometric view of the mounted valve adapter subassembly shown in FIG. 4A engaged with the mounted actuator adapter plug in accordance with principles of the invention.

DETAILED DESCRIPTION

Examples of the methods and systems discussed herein are not limited in application to the details of construction and the arrangement of components set forth in the following description or illustrated in the accompanying drawings. The methods and systems are capable of implementation in other embodiments and of being practiced or of being carried out in various ways. Examples of specific implementations are provided herein for illustrative purposes only and are not intended to be limiting. In particular, acts, components, elements and features discussed in connection with any one or more examples are not intended to be excluded from a similar role in any other examples.

Also, the phraseology and terminology used herein is for the purpose of description and should not be regarded as limiting. Any references to examples, embodiments, components, elements or acts of the systems and methods herein referred to in the singular may also embrace embodiments including a plurality, and any references in plural to any embodiment, component, element or act herein may also embrace embodiments including only a singularity. References in the singular or plural form are not intended to limit the presently disclosed systems or methods, their components, acts, or elements. The use herein of “including,” “comprising,” “having,” “containing,” “involving,” and variations thereof is meant to encompass the items listed thereafter and equivalents thereof as well as additional items. References to “or” may be construed as inclusive so that any terms described using “or” may indicate any of a single, more than one, and all of the described terms. In addition, in the event of inconsistent usages of terms between this document and documents incorporated herein by reference, the term usage in the incorporated references is supplementary to that of this document; for irreconcilable inconsistencies, the term usage in this document controls.

As discussed above, in valve apparatuses, it is sometimes desirable to have the actuator be connected to and/or removed from a valve stem of another operating member of a valve. In some valve systems, releasable engagement between an actuator to a valve body may involve manually connecting a valve, having an operating member extending

outwardly from the valve body along an axis of the operating member, to an actuator. For example, the actuator can include a latching mechanism to which the operating member of the valve engages and the operating member often includes a “notch” or “protrusion” that is on a plane perpendicular to the axis of the operating member. The latching mechanism of the actuator can have a planar surface that interfaces with a surface of the notch or protrusion to help secure the actuator to the valve body. To engage the notch or protrusion of the valve with the planar surface of the latching mechanism of the actuator, the valve and the actuator must typically be misaligned to insert the valve with the latching mechanism, and then realigned, which can be a difficult and time-consuming process. Such a process may also involve the use of additional tools.

A valve apparatus is provided where the actuator can be operatively connected to a valve stem of another operating member of a valve by a selectively releasable engagement apparatus, such that the actuator can be readily removed from or attached to the valve without the use of additional tools.

FIGS. 1A-C show an exemplary embodiment of an outer housing **100** of a valve adapter sub-assembly in accordance with principles described herein. The outer housing **100** has a recessed receptacle **110**. As shown in FIG. 1C, the receptacle **110** allows the outer housing **100** to receive a protrusion **600** from a valve body. The outer housing also includes a bore **120** for receiving the actuator adapter plug **300** of FIGS. 3A-C. An expansion spring **200** (shown in FIG. 2) may be placed within the outer housing **100**, the expansion spring providing radial pressure on outer housing (e.g., toward the axis **140**). In at least one embodiment, expansion spring **200** has three protrusions **210a-c** that fit within openings **130** to protrude into the outer housing bore; however, in other embodiments, the expansion spring **200** can include any number of protrusions.

FIGS. 3A-C show an exemplary actuator adapter plug **300** for an actuator in accordance with principles described herein. The actuator adapter plug **300** has a connector mechanism **310** for engaging with an actuator. In the embodiment shown, connector mechanism **310** engages with two upper brackets (anti-rotation and u-brackets) of an actuator. The actuator adapter plug **300** also includes a conical protrusion **320** opposite the connector mechanism **310**, and a peripheral groove **330** along an outer surface of the actuator adapter plug **300**.

FIG. 4A shows an isometric view of a valve adapter subassembly **400** having the outer housing **100** and expansion spring **200** mounted on a valve protrusion **600** of a valve. Actuator adapter plug **300** is mounted on an actuator **500** having two upper brackets **510** (called anti-rotation and u-brackets). Typically, in conventional systems, the valve protrusion **600** would engage directly with the brackets **510**. In doing so, the connection would involve engaging the notch or protrusion **600** of the valve with the planar surface of the latching mechanism **500** of the actuator. In such a system, the valve and the actuator must typically be misaligned from a common axis to insert the valve with the latching mechanism, and then realigned, which can be a difficult and time consuming process.

In accordance with principles described herein, the actuator adapter plug **300** slides onto the actuator **500**. The valve adapter sub-assembly **400** has the outer housing **100** that retains the expansion spring **200** and slides onto the valve protrusion **600**. The actuator **500** is driven down to the valve protrusion **600** until the top adapter **300** engages the bottom adapter **400** and the spring **200** is fully latched. Once

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engaged the geometry of the mated parts and the corresponding shafts prevents the disengagement of the adapters from each other and from the corresponding shafts. This reduces time and effort required to make a connection. No physical tools are required to engage or disengage the connection.

The conical plug geometry of the actuator adapter plug **300** interfacing with the outer housing **100** bore **120** allows the design to self-align and compensate for axis offset errors in any direction perpendicular to the shaft axes. Conical plug geometry also expands the spring **200** as shafts are brought closer together during assembly. The spring **200** then snaps into inner plug groove **330** and creates the final complete connection when the shafts are the correct distance apart.

FIG. **4B** shows the mounted valve adapter subassembly **400** engaged with the mounted actuator adapter plug **300** in accordance with principles of the invention.

Having thus described several aspects of at least one embodiment of this invention in considerable detail with reference to certain preferred version thereof, it is to be appreciated various alterations, modifications, and improvements will readily occur to those skilled in the art. Such alterations, modifications, and improvements are intended to be part of this disclosure, and are intended to be within the spirit and scope of the invention. Accordingly, the foregoing description and drawings are by way of example only. Further, the phraseology and terminology used herein is for the purpose of descriptions and should not be regarded as limiting. The use of "including," "comprising," "having," "containing," "involving," and variations herein, are meant to be open-ended, i.e. "including but not limited to."

What is claimed is:

1. A self-aligning connector system for connecting an actuator to a valve body of a valve, comprising:

an actuator adapter plug having a conical protrusion and a peripheral groove formed in an outer surface of the actuator adapter plug, the actuator adapter plug configured to be removably coupled to the actuator; and a valve adapter sub-assembly configured to be coupled to a valve protrusion of the valve body, the valve adapter sub-assembly comprising an outer housing having a bore configured to receive the actuator adapter plug subsequent to the valve adapter sub-assembly being coupled to the valve protrusion, and an expansion spring coupled to the outer housing and configured to provide radial pressure on the outer housing to receive the conical protrusion of the actuator adapter plug and latch onto the peripheral groove,

wherein the conical protrusion is configured to interface with the outer housing to self-align the actuator adapter plug and compensate for axis offset errors when the actuator adapter plug is inserted into the bore.

2. The self-aligning connector system of claim 1, wherein the conical protrusion is further configured to expand the expansion spring as the actuator adapter plug is inserted into the bore.

3. The self-aligning connector system of claim 1, wherein the actuator adapter plug further comprises a connector mechanism configured to engage with the actuator.

4. The self-aligning connector system of claim 3, wherein the connector mechanism is further configured to engage with at least one bracket of the actuator.

5. The self-aligning connector system of claim 4, wherein the connector mechanism is further configured to engage with at least one of an anti-rotation bracket and a u-bracket of the actuator.

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6. The self-aligning connector system of claim 1, wherein the valve adapter sub-assembly further comprises a recessed receptacle for receiving the valve protrusion of the valve body.

7. The self-aligning connector system of claim 1, wherein the expansion spring comprises at least one protrusion configured to engage with the peripheral groove.

8. The self-aligning connector system of claim 7, wherein the outer housing comprises at least one opening configured to allow the at least one protrusion of the expansion spring to protrude into the bore.

9. The self-aligning connector system of claim 8, wherein the at least one protrusion of the expansion spring includes a plurality of protrusions and the at least one opening of the outer housing includes a plurality of openings.

10. The self-aligning connector system of claim 9, wherein the plurality of protrusions includes three protrusions.

11. A method for coupling an actuator with a valve body of a valve, the method comprising:

removably coupling a connector mechanism of an actuator adapter plug to the actuator;

coupling a valve adapter sub-assembly to a valve protrusion of the valve body;

subsequent to coupling the valve adapter sub-assembly to the valve protrusion, inserting a conical protrusion of the actuator adapter plug into a bore of the valve adapter sub-assembly coupled to the valve body;

providing radial pressure toward an axis of the valve adapter sub-assembly as the conical protrusion is inserted into the bore; and

latching the actuator adapter plug to the valve adapter sub-assembly using an expansion spring of the valve adapter sub-assembly that fits into a peripheral groove of the actuator adapter plug,

wherein inserting the conical protrusion into the bore of the valve adapter sub-assembly comprises self-aligning the actuator adapter plug to compensate for axis offset errors as the conical protrusion is inserted into the bore.

12. The method of claim 11, wherein removably coupling the connector mechanism to the actuator comprises sliding the connector mechanism into at least one bracket of the actuator.

13. The method of claim 11, wherein coupling the valve adapter sub-assembly to the valve protrusion of the valve body comprises receiving, with a recessed receptacle of the valve adapter sub-assembly, the valve protrusion of the valve body.

14. The method of claim 13, wherein receiving the valve protrusion of the valve body includes sliding the protrusion of the valve body into the recessed receptacle.

15. The method of claim 11, wherein inserting the conical protrusion into the bore of the valve adapter sub-assembly comprises expanding the expansion spring as the conical protrusion is inserted into the bore.

16. A valve assembly comprising:

an actuator;

a valve body;

an actuator adapter plug configured to be removably coupled to the actuator;

a valve adapter sub-assembly configured to be coupled to a valve protrusion of the valve body, the valve adapter sub-assembly comprising an outer housing having a bore configured to receive the actuator adapter plug subsequent to the valve adapter sub-assembly being coupled to the valve protrusion; and

the actuator adapter plug including means for self-aligning the actuator adapter plug to compensate for axis offset errors when the actuator adapter plug is inserted into the bore and for coupling the valve adapter sub-assembly to the actuator adapter plug.

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17. The valve assembly of claim **16**, wherein the actuator adapter plug further comprises means for engaging with the actuator.

18. The valve assembly of claim **17**, wherein the means for engaging with the actuator is opposite the means for self-aligning the actuator adapter plug.

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19. The valve assembly of claim **16**, wherein the valve adapter sub-assembly further comprises means for receiving the protrusion of the valve body.

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